

QUARTERLY PROGRESS REPORT

DRD 875MA-003

January 2005 - March 2005

**Marshall Space Flight Center
Safety and Mission Assurance Mission Services Contract
NAS8-00179**

Approved:

Original signed by:

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1.0 INTRODUCTION

Hernandez Engineering, Inc. (HEI) successfully performed all required activities and tasks, as described in this report, in fulfillment of their Safety and Mission Assurance (S&MA) Mission Services Contract (NAS8-00179) with NASA's Marshall Space Flight Center (MSFC). This report covers a three-month period of the contract's second quarter of the fourth option year: January 2005 through March 2005.

2.0 GENERAL MANAGEMENT

2.1 Data Requirements

The second quarter of the fourth option year of the S&MA Mission Services contract was successfully completed on March 27, 2005. All Data Requirements (DR) Documents were submitted on or ahead of schedule throughout the quarter. They included DRD 875CD-001 On-Site Employee Location Listing; DRD 875MA-002 Financial Management Reports; DRD 875MA-003 Progress Reports (Monthly/ Quarterly); DRD 875MA-006 Operations Plan, Problem Assessment Center (PAC); DRD 875MA-007 Quarterly Open Problems List; DRD 875MA-008 Monthly Newly Opened/Closed Problem Summary; DRD 875SA-002 Mishap and Safety Statistics Reports; and Quarterly Safety Performance Evaluation.

2.2 Personnel Status

(b) (4)

3.0 BUSINESS MANAGEMENT

We have experienced no financial or business management problems during this period. We attribute this to close attention to details, effective use of established controls designed to efficiently respond to program changes---both anticipated and unexpected---and the continuing support of our corporate financial group's dedicated efforts at controlling overhead expenses.

The contract continues to have a total cost under-run at the end of this period---see the March 2005 Monthly Financial Report, DRD 875MA-002, for specifics. Attachment 2, Man-Hours Expended, of this report contains a description, by major task, of the total man-hours expended this period.

(b) (4)

4.0 PERFORMANCE OF WORK AND USE OF FACILITIES AND EQUIPMENT

4.1 Safety

4.1.1 Industrial Safety (IS)

The Industrial Safety (IS) team initiated the CY05 OSHA compliance annual facilities inspections, performed 116 OSHA compliance annual facilities inspections and provided all

required reports in a timely manner. Also, IS performed 322 construction site compliance inspections to monitor adherence to OSHA and MSFC safety standards. All facility safety violations were documented in the SHEtrak database in order to assure MSFC's compliance with OSHA, NASA, and other consensus code requirements.

Among other activities, IS: (1) participated in two final safety inspections of facilities under renovation or construction; (2) reviewed 57 sets of facility design drawings for compliance with OSHA and consensus codes; (3) assisted QD50 in development and processing, for web page posting, three Safety Bulletins and one Shop Talk safety information topic; (4) taught three training sessions to supervisors on how to perform monthly workplace safety visit inspections; (5) performed two annual fire drills; (6) participated in one preconstruction conference of facilities being modified or upgraded; and, (7) as a specific customer request, HEI continued to provide an experienced senior Industrial Safety Engineer who monitored construction and maintenance operations when working on energized systems for adherence to proper Lockout/Tagout procedures. Although budget cuts led to a reduction from 3-4 days per week to one day per week during the last month of this period, 208 locations were surveyed.

For two of the three months during the reporting period IS continued to provide a ^{(b)(4)} to assist the Safety, Health and Environmental (SHE) Communications and Training Teams and general communication of safety awareness information/materials to all MSFC employees. Assistance included: (1) prepared and processed, for web page posting, the weekly SHE highlights and monthly SSWP safety required and optional focus topics; (2) prepared monthly SHE communications plans; and, (3) developed multiple innovative safety awareness communications materials including safety announcements on MSFC TV.

In support of S&MA Technical Directive Number 0131, IS continued to provide additional administrative and technical support to the MSFC SHE Committee to include: (1) assist with preparation of the annual SHE Program annual progress report for CY 2004; (2) assisted with finalizing the CY 2005 SHE Program Annual Plan; (3) tracking of SHE actions; (4) continued to assist the SHE Committee Chairperson and QD50 support bi-monthly SHE Committee meetings, including collection and organization of pre-meeting briefing charts, serving as recorder, and preparing draft meeting minutes; and, (5) to assist in documenting and tracking SHE Committee and external SHE Program evaluation action items. IS continued to coordinate with the HEI IM team, QD50 and the SHE Planning Team to plan and initiate development of a new S&MA database, SHE Committee Action Item Tracking System (SHECAITS).

IS initiated, completed or followed-up on more than a dozen facility safety assessments (SA). Examples include: (1) continued to support the Return to Flight (RTF) Verification Wide Panel testing in building 4619; (2) performed a SA for the Micrometeoroid/Space Debris Light Gas Gun in building 4612; (3) reviewed the Solid Rocket Booster Hold-down Post/Nut Pyrotechnic test in building 4619; (4) reviewed storage requirements to store various flammable solids (Alkali Metals) at building 4655; and, (5) reviewed explosives quantity-distance requirements for a Liquid Hydrogen Storage Vessel at Test Stand 115

IS continued to support the implementation of the NASA lifting standard, NASA-STD-8719.9 by providing day-to-day advice and assistance to S&MA customers. IS advised civil service and contractor managers, supervisors and employees on requirements for lifting equipment usage in support of the MSFC SHE Program. IS updated critical lift certification packages for four refurbished cranes in building 4755 and assisted QD50 in the review of the planned use of a mobile crane for lifting roofing materials at building 4707. Also, IS continued to be an active participant in the Lifting Device Equipment (LDE) SHE subcommittee. In support of the task to administer proficiency exams to civil service and contractor operators of overhead cranes, fork lifts, small truck mounted hoists, and aerial lifts, IS administered hands-on proficiency examinations to nine overhead crane and 17 forklift operators in support of the MSFC Personnel Certification Program. To date, IS performed 26 proficiency exams for CY05.

IS continued to provide (b) (4) to the MSFC Test areas. Examples of support included: (1) reviewed and approved multiple operating and test procedures for hazardous operations; (2) reviewed the Quantity-Distance (QD) requirements for the potential propellant storage facilities in the test areas; (3) participated in all pre-test and post-test safety and quality activities in support of the Thiokol 48" MNASA motor test firing; (4) actively participated in daily and weekly safety meetings/safety stand downs of the MSFC East and West Test Area S&MA Safety and Quality team and the Test Laboratory, Engineering Directorate; (5) as an additional duty, served as the alternate safety representative for test area facilities; and, (6) provided daily support to test engineers and S&MA personnel on technical issues to include performing numerous test procedure reviews.

(b) (4) at Stennis Space Center (SSC) continued their support to SSC S&MA by preparing system safety analyses and presenting test readiness review analysis data to meet Propulsion Test Directorate compliance requirements at the E-Complex Test Facility. Programs and projects assessed included: USFE (Upper Stage Flight Experiment), IPD (Integrated Powerhead Demonstrator), External Tank Panel Test Project, Ice/Frost Characteristic Testing, E-1 Test Stand Control Center, ITA (Instrumentation Test Article) and HMTP (Hybrid Materials and Gas Generator). In addition, examples of the technical support function included: participating in design reviews, facility upgrade reviews, weekly telecons, technical interchanges, scheduling & sidebar meetings, delta tabletop discussions, etc.

4.1.2 System Safety Engineering

System Safety Engineer (SSE) supported the review and update of baselined S&MA documents for the Constellation Program. SSE supported meetings to address changes to the Constellation Hazard Analysis Methodology Document and the Constellation Safety Requirements Document. SSE completed all assigned action items per revision schedule.

SSE responded to a 01/27/05 request from the NASA Academy of Program and Project Leadership (APPL) to prepare and present an overview to S&MA and its functions to an on-going Foundations of Project Management class in Huntsville. The S&MA Module was presented on 01/28/05 and very well received by the class and instructors.

SSE took part in the training at JSC during the week of 01/23-29/05. The Exploration Systems and Operations (EXPO) course provides an end-to-end view of most aspects and systems

necessary to support Moon, Mars, and Earth orbiting systems that involve human spaceflight. Many of the significant aspects of designing for crewed exploration missions and the supporting systems and subsystems are discussed and the associated relationships are addressed. SSE considered this course outstanding and a useful tool in developing the S&MA support to these types of programs. Senior S&MA engineers supporting the current Exploration Systems Mission Directorate will benefit and provide enhanced support to the customer after completion of this course.

SSE supported weekly meetings of the ET Excitation Power Box (EPB) and meetings to examine project verifications.

SSE assisted the Reinforced Carbon-Carbon (RCC) On-Orbit Crack Repair (ROCR) Project in identifying the requirements that must be met for the Crack Repair Material (CRM) to be flown on STS-114. The project will first meet the requirements necessary for the material to be classified as "safe-to-fly" and then "safe-to-apply" and finally a complete certification for re-entry. The CRM will most likely only have a "safe-to-apply" certification complete for STS-114. SSE supported the regular meetings of the ROCR team. SSE also wrote and presented the Risk Assessment Executive Summary Report (RAESR) and hazard reports at the phase II SMART review on March 3rd for the Crack Repair Material. SSE has been editing the hazard reports in response to the comments made by the SMART panel. SSE supported a meeting of the Marshall and JSC S&MA staff in Houston and the phase II SMART review and CDR for the Crack Repair Material application gun (the latter two by teleconference).

SSE attended the mandatory meetings for the Solid Rocket Booster (SRB) team. SSE prepared a Change Evaluation (CE) for ECP-4169, and updated and assembled the hard-copy versions of the SRB Integrated Hazard Reports for HEI system safety records.

SSE supported the integration effort for Shuttle Integration Return to Flight activities. SSE participated in the Marshall Safety Engineering Review Panel training. SSE has been asked to be an Advisory Panel Member. SSE has continued the effort on the Double Diamond audit for the Marshall elements. SSE has been working with the S&MA lead for PSE&I to develop a methodology for supporting the Integrated Safety Engineering Review Panel and staffing needs to support the effort.

SSE reviewed change requests, Fault Tree Double Diamond Transfers from the MSFC Elements and review of Integrated Hazard Reports for S&MA Integration. SSEs have worked with the customer to develop a format for tracking review comments for the Integration team. SSE represented the customer at the newly developed Integrated Safety Engineering Review Panel ran concurrently with the TIM. SSE worked with customer to develop and identify additional areas of needed work.

SSE team supported the independent audit and review of MSFC Shuttle Element Fault Trees Double Diamonds, reviewing each applicable element hazard report fault tree to assure that all identified double diamonds were accounted for and traced to an Integrated Hazard Report. Three of the four element audits have been completed.

SSE participated in the External Tank Design Certification Review II (DCR II) held 01/24/05-02/04/05, and 2/14/05-02/18/05 at the MAF. SSE evaluated the Development Flight Instrumentation (DFI) Hazard Report (E.06) and supporting documentation. SSE primary responsibility at DCR II, part 2 was to evaluate the Loss of Thermal Protection System (TPS) Hazard Report (T.02) and supporting documentation. SSE worked with the Safety Engineer for T.02 to resolve inconsistencies in the Hazard Report (HR), as well as offer "make better" suggestions. Most of the suggestions were incorporated into the HR. These actions did not require RID or Request for Information paperwork as they were worked real time.

SSE supported S&MA QD20 at the Space Shuttle Program Special Systems Integration Control Board (SICB). SSE supported various integration activities during the period.

SSE acted as the MSFC S&MA representative in the Integration Safety Engineering Review Panel (ISERP) activities and attended the Space Shuttle Program Special Systems Integration Control Board (SICB) activities during this period. A number of integrated hazard reports were disposed through the ISERP and SICB this period. SSE supported various integration activities during the period. SSE supported reviews and preparation for the IMPS Technical Interchange meeting. SSE participated in dispositioning of eight IMPS hazards. These were reviewed and elevated to the SICB for disposition. SSE also supported the SICB for these items.

SSE participated in two week long meetings of the Space Shuttle Safety Review Panel (including providing MSFC representation for certain sections of the meetings). The SSRP met from February 28-March 4, 2005, discussing several Orbiter Reports during a TIM for the Integrated TPS Inspection and RCC Repair Activity. The SRB Project presented one HR and 16 related CILs to the panel. This was the last of four SRB TIMs covering their RTF items. Other topics during the week included 6 KSC GSE CILs and one Integrated Hazard Report. The week of March 7th, during a special SSP main propulsion system (MPS) Integrated Hazard Analyses TIM, the retirement of the SSRP and transition to the new SSP Safety Engineering Review Panels with JSC and MSFC SSRP members was discussed.

SSE supported the planning for the new Marshall Safety Engineering Review Panel (MSERP), providing comments and suggestions to the QD lead. SSE has supported the QD lead in the development of an MSERP implementation plan. SSE will provide technical support and process management functions for the new panel chair. SSE is also developing training material for the new panel.

SSE continued to work actions from the Intelligent Pressure Transducer (IPT) CDR IPT held on 01/10-12/05. MSFC S&MA is performing an analysis considering the effects of a backflow of energy through the addition of a cable from the IPT to the Safe and Arm device and has contacted the JSC Batteries group for the use of a Lithium battery. Both items are still pending resolution.

SSE participated in the Space Shuttle Main Engine (SSME) System Safety and Reliability teleconferences, and the SSME team teleconferences; also, reviewed notes on SSME project status and recent technical issues. SSE also began evaluating draft copies of 11 proposed new Integrated hazard reports in order to meet the rapid-turnaround review schedules; also generated

a safety assessment for a recent technical issues and continued participating in the teleconferences held to review some of the remaining draft SSME FMEA/CIL updates for RTF.

SSE completed evaluation of six SSME changes (all of which were recommended for approval as written) and 17 Systems changes (11 of which were recommended for approval with changes, and the remaining six for approval as written); also, began evaluation of several additional SSME and Systems changes that were recently received for review.

SSE has continued evaluating Integrated hazard reports and providing SSME Safety evaluation comments to MSFC S&MA for coordination with the reports' authors. Evaluation of 24 draft reports was completed with several errors found and appropriate changes documented for S&MA. Four additional Integrated hazard reports, officially released for review on Level II change requests (CRs), were also evaluated and comments submitted.

SSE completed its evaluation of the last two sets of Space Shuttle Main Engine (SSME) Return-to-Flight (RTF) Failure Modes and Effects Analysis / Critical Items List (FMEA/CIL) and Hazard Analysis Updates required for RTF.

SSE supported telecons to discuss the upcoming Node 3 Closeout Technical Interchange Meeting and Mandatory Inspect Point meetings occurring at Alenia, although safety has no issues MSFC S&MA has not been invited to attend any of these meetings occurring at Alenia. SSE supported the MVCB, no safety issues were discussed. SSE reviewed 110 changes, one of which had safety impact (using liquid locking compound as a secondary method of positive locking). This change was deemed acceptable as written. SSE reviewed the Node 2 stress report and qualification documents presented as closure rationale for safety verifications on hazard reports. SSE reviewed the phase III hazard reports and provided updates to the SVTL and provided rationale to close several of the Operational Control Agreement Document (OCAD's) that were previously rejected. Updates to Node 2-0004 were made in order to support the rationale to close the OCAD. SSE continues to review closure data from Alenia and provide updates to the SVTL. SSE updated the remaining open delta phase II hazard reports for Node 3 with information obtained from notes during the review and synopsis notes delivered from JSC Station Review Panel.

SSE reviewed the minutes from the delta phase II safety review for ECLSS. One hazard report will require updates from the thermal subsystem and may be several months from completion. These thermal updates will require the thermal team to review the acceptance data by serial number and provide the proof and burst data on those components.

SSE supported the Node 3 T&V telecons where requirements closure and completion dates for the VCN's were discussed. Closure data for about 21 of the safety VCN's have been submitted to NASA by Alenia. SSE is reviewing this data to verify its completeness in order to close the subject VCN's, and has assembled 2 VCN packages and submitted them for review. SSE reviewed closure data provided by Alenia on several open S&MA Review Item Discrepancies (RID's).

SSE completed the Flight LF-1 Multi Purpose Logistic Module (MPLM) / Orbiter Reflight Assessment and provided it to the MPLM Project for final signature. SSE also continued its work on the Flight ULF-1.1 MPLM/Orbiter Reflight Assessment. SSE supported the normal MPLM team meetings and the MPLM Station Problem Resolution Team (SPRT) meeting. Change number 5 to hazard report MPLM/Orbiter Integrated (MOI-7) was approved by the Payload Safety Review Panel (PSRP). SSE made its MPLM presentation to the PSRP. SSE submitted a ground safety assessment to the Ground Safety Review Panel (GSRP) for the changes made to the ground cable for the Programmable Thermostat System. The assessment was approved and the cable was used successfully during system testing. SSE performed a ground safety assessment of the Laser Gauge system and submitted it to the Ground Safety Review Panel. This piece of equipment is expected to be used to make peaking and mismatch measures on the MPLM structural weld. SSE reached an agreement with the Missions Operations Directorate (MOD) and the Payload Safety Review Panel (PSRP) about wording for the submission of an Operational Controls Agreement Document (OCAD's) entry into the OCAD database. A draft version of the latest update to MOI-7 was submitted to the PSRP for final comment. SSE received word that OCAD 36999 was approved by the Mission Operation Directorate (MOD). This OCAD was submitted in support of change 5 to hazard report MOI-7, allowing SSE to close out the Safety Verification Tracking Log (SVTL) for the MPLM/Orbiter Integrated Reflight Assessment for the Flight LF-1 mission. SSE began work on a presentation to the PSRP on all of the MPLM problems encountered in the last two years. This presentation was requested by the PSRP as part of the approval process for approving the MPLM/Orbiter Reflight Assessment for Flight LF-1. SSE began assessing all S&MA related MPLM open paperwork. SSE submitted a copy of the Flight ULF-1.1 (STS-121) MPLM/Orbiter Reflight Assessment to the MPLM Project for final review.

SSE supported the Urine Processor Assembly (UPA) and Water Processor Assembly (WPA) team meetings. SSE also supported the UPA bench top procedure review and made additional updates to the Water Recovery System (WRS) Hazard Analysis. SSE reviewed 5 UPA test procedures in support of the UPA testing. SSE continued working on the WRS Phase III Flight Hazard Analysis. Additional updates were made based on preliminary feedback from the WRS Project. SSE also provided a copy of the WRS and WPA Safety Verification Tracking Logs (SVTLs) to the WRS Project Verification Group.

SSE supported the normal Biological Research Project (BRP) meetings and the Station Problem Resolution Team (SPRT) Meeting. There were 6 Manufacturing Action Requests (MARs) reviewed and 2 approved.

SSE performed a hazard analysis for loss of cooling to the Oxygen Generation System (OGS)/Water Recovery System (WRS) racks in order to submit closure for a Review Item Discrepancy (RID). A new rack level hazard report or update of a Node 3 hazard report will document the hazard analysis. The design of the Oxygen Generator Assembly is changing to meet system safety requirements. Several design options are being considered. Since the preferred design solution does not meet the safety requirement but technically has a safe design, SSE is arranging a small, informal telephone discussion with the ISS SRP Chairman to determine if this approach is feasible from a safety standpoint. SSE continues to work with Hamilton Sundstrand, MSFC, and Boeing on safety issues regarding the OGS going in the

United States Laboratory. SSE reviewed Oxygen Generation Assembly (OGA) and Node 3 Hazard Reports for potential impacts related to OGA in the United States Laboratory (USL). Two OGA hazards have been identified that will be impacted by placing the OGA in the USL. Also, SSE is reviewing the OGA Hazard Reports for verifications that Hamilton Sundstrand has documented as a MSFC responsibility. SSE reviewed 67 OGA Safety verifications. To date, 289 verifications have been submitted to Safety for review. Of these, 244 have been reviewed and 32 are waiting on a Software Test Report from Hamilton to complete their review. This leaves 13 verifications that need to be reviewed by Safety.

For the Materials Science Research Rack (MSRR-1) SSE completed an evaluation with the system engineer of the Requirements & Verification Compliance (RVC) document vs. the hazard reports, to ensure consistency among the documents. This hadn't been done in a while, so a thorough review was made, to ensure that all requirements from the safety data package are reflected in the RVC, and the documents are still applicable in light of the considerable time since the phase II flight safety review. Issues that could be closed were addressed, while three actions were taken. These are issues that require input from certain WBS managers, and contact has been initiated to obtain responses from the appropriate individuals. SSE continues to update the existing safety data package to a phase III maturity. SSE has provided additional input to UAH regarding the scope of the Space Products Development (SPD) part of the integrated phase III package. SSE has prepared inputs to the project schedule, and has responded to various requests for information/assistance from the system engineer. SSE has provided input to the flight and ground safety review schedule dates.

For Lab on a Chip Applications Development (LOCAD) System Safety Engineering (SSE) is supporting the incorporation of comments to the System Safety section and Industrial Safety section of the LOCAD Safety & Mission Assurance Plan. SSE submitted comments to the Phase 0/I/II safety data package. SSE is also preparing essential system safety elements of the LOCAD Project Plan. SSE submitted a System Safety section and an Industrial Safety section to the LOCAD Safety & Mission Assurance Plan.

SSE prepared the Transport Safety Assessment for Disposal of the Microgravity Science Glovebox (MSG) Video Drawer Battery Pack and CSLM-2 Foam Inserts on Soyuz or Progress. Along with others at JSC, MSFC SSE was cited in an email from the JSC Payload Safety Engineer (PSE) for providing a one day turnaround of the assessment.

For the Microgravity Sciences Glovebox (MSG), SSE participated in a telecon with the Payload Safety Review Panel (PSRP) and ESA to discuss the restriction placed on operation of the MSG currently on orbit on ISS. Flight rule number I10-2.1-8 requires that "No investigation that requires the Microgravity Sciences Glovebox (MSG) Facility to provide a Level of Containment shall be operated in the MSG." SSE supported ongoing review of the MSG Integration Review/Approval Matrix to be included in the MSG Data Management Plan. The matrix defines which verifications must be approved by System Safety. In a telecon with the PABS experiment Payload Safety Engineer at Ames Research Center, System Safety Engineering (SSE) discussed biosafety levels, plans for sample containment, and anticipated spill procedures. SSE reviewed briefing materials considering the feasibility of using Kapton tape as a level of containment for this investigation. SSE participated in the MSG Level IV CCB addressing changes to the MSG

Investigation Interface Requirements document, MSFC-RQMT-2888. Changes include removal of the blanket requirement for crew surveillance of combustion experiments, previously briefed to the PSRP with their concurrence. Crew surveillance requirements will be addressed on a case-by-case basis by the PO at the phased safety reviews with the PSRP. SSE reviewed baseline concept description and operations concept documents for the SAME investigation (formerly SMOKE). SSE continued preparation of the Integrated Safety Data Package for the Boiling Experiment Facility (BXF) in MSG. SSE participated in review of the S&MA Plan for the MSG Integration Project, which has now been baselined. SSE participated in review of the ESA document, MSG Logistics Analysis Data, MSG-RIBRE-TN-0032, with regard to limited life items. MSG neoprene gloves with Norsorex seal rings, as well as facility Norsorex sealed access ports and front window assembly, have exceeded their expected lives.

SSE participated in an Integrated Hazard TIM for Main Propulsion System. In support of this TIM SSE reviewed 13 Integrated Hazard Reports for the Space Shuttle Vehicle (SSV). SSE also supported an RSRM Debris TIM that discussed how RSRM can contain impact from other elements debris, and explained how RSRM debris will not affect the SSV. SSE participated in discussions concerning Nozzle, Throat Ring Finger voids, Radial Offset deviation, and RT-455 Cork and Paint issues. These discussions with ATK Thiokol were working level. SSE has also been heavily involved in reviewing Integrated Hazard Reports for the Space Shuttle Vehicle (SSV). SSE performed a Safety Flow down review of 5300.4 requirements against ATK Safety Plan and sent comments to Thiokol. SSE reviewed 2 Integrated Hazard Reports for the Space Shuttle Vehicle (SSV). SSE also completed a verification of a double diamond audit performed by PSE & I.

For Glovebox Integrated Microgravity Isolation Technology (g-LIMIT), SSE supported an investigation into the adequacy of connectors for the Isolator. The video and experiment power pins had six (6) out of 105 wire strands removed in order to fit to the connector. An assessment was performed to ensure that the wires were adequate for all loads expected. A review of the discussions during the Microgravity Science Glovebox (MSG) integrated phase III review, held during October 2001 was conducted. It was found that this issue had been thoroughly addressed, and the current g-LIMIT design is compatible with the capabilities of MSG. SSE supported completion of Command & Data handling (C&DH) timeline testing on the Flight Unit Spare (FUS). Areas included in the testing were the interface between the g-LIMIT and MLC, expanded operations procedures and commanding, and timeline compliance. Error messages and responses were also verified. The testing was completed satisfactorily.

4.2 Reliability

4.2.1 Reliability & Maintainability Engineering (R&ME)

During the 2nd Quarter of Fiscal Year 2005 Reliability and Maintainability (R&ME) continued to support the Constellation Program (QD10) through its involvement in meetings and telecons regarding reviews, comments and revisions of the FMEA/CIL Methodology requirements document, in order to provide up to date information for release. R&ME was designated this quarter as the "Change Package Engineer" for configuration management requiring access to the Wind-Chill program in order to support configuration management activities. R&ME was also

tasked to review and provide inputs/comments on the latest requirements documents generated for the Human Rated Launch Vehicle (HRLV).

R&ME continued to provide dedicated support this quarter to Return-To-Flight (RTF) activities as well as day-to-day activities by thoroughly reviewing all current SRB, RSRM, SSME and ET Critical Item Lists (CIL's) and potential CIL's for retention rationale pertaining to the Space Vehicle Assurance Group (QD20). In addition to reviewing numerous CIL's, R&ME supported efforts involving Preliminary Requirements Reviews (PRR's), Critical Design Reviews (CDR's), Delta Production Readiness Reviews (DPRR's), Design Certification Reviews (DCR's), Technical Interchange Meetings (TIMs) and audits for new hardware designs or redesigns.

R&ME also provided support for technical issues such as: SRB's Integrated Electronics Assembly (IEA) upgrade, SRB's Booster Separation Motor (BSM) igniter redesign and strut retainer cable, SRB's misconnected cable during BI124R aft skirt backshell re-termination, SRB's Government Furnished Equipment (GFE) PIC cards functional test failure, SRB's baselining process for new and withdrawn COQ's for RTF activities, SRB's debris issue due to liftoff ignition forces, SRB's double diamond audit assessment of hazard analyses and fault trees for consistency, SRB's broken connector backshell issue of LH SRB Upper Strut Cable X13W23, SRB's failure of the IEA Upgrade Program's qualification unit and SRB's Orbiter Bus C failure issue; RSRM's ply-lifting issue, RSRM's O-ring resiliency testing, RSRM's Intelligent Pressure Transducer (IPT), RSRM's RT455 spice plate issue, RSRM-92 Stiffener Stub paint flaking issue, Inconel bolt cracking issue, RSRM's TIM on STS115 (RSRM-91) aft booster build, RSRM's Corrosion Issue, RSRM's double diamond audit assessment of hazard analyses and fault trees for consistency and the integrity assessment of RSRM's Thermal Protection System (TPS); ET's Development Flight Instrumentation (DFI) CDR, ET's Design Certification Review (DCR) Phase II, ET's LO2 Feedline Bellows Ice Elimination effort, ET's Enhanced Launch Vehicle Imaging System (ELVIS) Design Certification Review (DCR) Phase I, ET's RTF Instrumentation effort, ET's electronics box for future camera battery replacement, ET's double diamond audit assessment of hazard analyses and fault trees for consistency and matrix correlation of ET's LCCs, FMEA/CILs, Hazard Analyses and OMRSDs; and for SSME's Agenda and Action Item Tracking Log for System Safety and Reliability, SSME's Accepted Risk Hazard Analysis review and SSME's double diamond audit assessment of hazard analyses and fault trees for consistency.

R&ME continues its involvement with: post PDR efforts on the SSP's Reinforced Carbon-Carbon (RCC) CRM team, plug repair project and presenting RCC P-FMEA and FMEA analysis at Phase II of the SMART Board and CDR, support to SSP's Integration on OMRSD updates, the OMRS Working Group and the Launch Commit Criteria (LCC) Working Group, participating at the SSP's Special Systems Integration Control Board (SICB) in order to provide dispositions to the PRCB, and assessing hazard analyses and fault trees for consistency during the Shuttle Integration double diamond audit.

R&ME continued to provide dedicated support this quarter to the International Space Station (ISS) Program's (QD30) First Material Science Research Rack (MSRR-1) project. R&ME presented the MSRR-1 Limited Life Items List to the MSRR-1 board for baselining the document. The board accepted to baseline the document after reviewing the changes that were

made based on the comments that were received during the baselining review. R&ME also revised the MSRR-1 Master Controller (MC) Reliability Prediction based on the updated parts list. The prediction is according to the MIL-HDBK-217 Notice F Part Stress Analysis. As per the analysis the Mean Time between Failures (MTBF) calculated for the Master Controller was reduced from the previously predicted value, but the value is still greater than the MC specification. The new MC MTBF number was rolled into the MSRR-1 EC System MTBF which also reduced, but still is within the specified value. There were no significant changes in the MSRR-1 Mean Time to repair (MTTR) and Mean Maintenance Crew Hours (MMCH) estimates based on the new MC MTBF number.

Additional support to ISS was the completion of Revision D of the OGS FMEA along with an update to the OGS Maintainability Analysis and Limited Life Items List. R&ME coordinated efforts with MSFC S&MA, the Regen ECLSS Project and Boeing to review/discuss delivery of the Regen ECLSS R&M data to Boeing. As a result of this meeting R&ME provided a CD to Boeing containing a draft of the WRS and OGS R&M documents (i.e. FMEA/CIL, Maintainability Analysis, Limited Life Items List). A copy of the CD was also provided to S&MA for coordination with the ECLSS Project. R&ME also provided a CD to Boeing containing the current Hamilton-Sunstrand WPA and OGA FDIR analyses. R&ME submitted updated WRS FMEA worksheets to reflect WPA FMEA Rev F to Boeing. The Regen ECLSS Project is to review and approve OGS R&M documents (FMEA/CIL, Maintainability Analysis, Limited Life Items List) in time to support the December 2005 OGS FCA. Any comments against the documents will be incorporated by R&ME with updates provided to Boeing. The Regen ECLSS Project is to review and approve WRS R&M documents (FMEA/CIL, Maintainability Analysis, Limited Life Items List) in time to support the March 2006 WRS FCA. Any comments against these documents will be incorporated by R&ME with updates provided to Boeing.

R&ME continued as an active member of the Space Shuttle Program (SSP) Reliability and Maintainability Working Group and the International Space Station (ISS) Reliability and Maintainability Panel, held jointly each week with Johnson Space Center (JSC) to ensure that R&M programmatic and technical requirements are implemented within each program. R&ME continues with providing a weekly status of R&M risk items to the SSP's S&MA Working Group.

R&ME training and knowledge enhancement of the Space Shuttle Program (SSP) remained active during 2nd Quarter Fiscal Year 2005. R&ME training included briefing the SLaTS class on Basic Reliability & Maintainability, reviewing the MSFC S&MA R&M Professional Development Roadmap document to provide comments to the Deputy S&MA Director, and presenting Basic FMEA/CIL instruction material during R&M's monthly meeting.

4.2.2 Problem Assessment Center Operations

HEI's Problem Assessment Center (PAC) personnel processed and coordinated disposition of problem reports; coordinated the MSFC Problem Assessment System; coordinated problem processing; participated in 3 STS-114 preparation simulations; worked with the prime contractors in implementing NSTS 08126 Shuttle PRACA Requirements Rev J and evaluating in-family/out-of-family requirement changes, drafted the Constellation PRACA methodology

document, and operated the Corrective Action System (CAS). The PAC received and entered 37 new problem report (PR) into MSFC's Problem Reporting and Corrective Action (PRACA) System, coordinated MSFC interim closure of 15 PRs, received 15 prime contractor closure recommendations, supported MSFC full closure of 24 PRs, coordinated non-problem closure of 13 problems, and performed 240 individual PR database updates and reviews. PAC conducted 7 SSME problem review boards (PRBs) resulting in dispositioning 20 of 22 problem reports presented, including maintained storage of supporting Unsatisfactory Condition Report (UCR) data on a common-access server and coordinating pre-review of dispositions by the Engineering Directorate prior to bringing UCRs to the board. The PAC generated or updated trends for MSFC Shuttle problems submitted as newly opened and for closure. PAC also generated, evaluated, and distributed monthly problem bubble trend risk charts and briefed the charts at the monthly SRB Problem Assessment System (PAS) review. PAC reviewed 13 requests for access to the MSFC PRACA database and granted all of them. PAC requested and monitored implementation of enhancements to the MSFC PRACA data system, including linking of Adobe Acrobat images to problem files, automated generation of Shuttle milestone charts, a new trend report formats, adding Effectivity Text as a selectable output field, and expanded/improved word search capabilities.

In support of Return-To-Flight, PAC met with SSME hardware contractors at KSC and coordinated update of their internal problem processes for compliance with Revision J to NSTS 08126; assisted in evaluating a shuttle change regarding in-family/out-of-family definition, and assisted the newly formed PRACA Working Group in defining common hardware processing. The PAC also obtained waterfall charts from each shuttle prime contractor for accomplishing problem dispositions in support of the return-to-flight schedule, monitored compliance with these schedules, and kept MSFC S&MA and Shuttle Program S&MA informed of open MSFC PRACA problems against STS-114 on a weekly basis. PAC supported the Shuttle Assurance Department in interpreting, establishing, and documenting procedures for compliance with Certification of Flight Readiness compliance. PAC provided open problem listings in support of the STS-114 ET/SRB Mate Review and STS-114 Orbiter Rollout Review.

In support of the Constellation Program, the PAC drafted the Constellation PRACA methodology document, coordinated review of the draft by a joint JSC, KSC, and HQ PRACA development team, and revised the document based on team decisions. The resulting document was then formally submitted to general Constellation community review. Paragraphs describing PRACA activities during the different Constellation development phases were also generated for inclusion in the Systems Engineering Management Plan (SEMP).

The PAC provided various problem data in support of NASA and MSFC analyses. Regular activities included providing daily KSC PRACA shuttle problem summaries, daily MSFC PRACA open-against-next-mission summaries, daily KSC Resident Office reports, monthly newly opened/closed problem summaries, weekly SRB PRACA and ALERT activities and status reports, and quarterly Open Problems List (OPL). Special activities included: (1) obtaining SRB and ET foam and TPS problem tabulations in support of the ET Critical Design Review; (2) providing ET LO2 feedline bellows problems in support of a redesign study; (3) searching KSC PRACA and providing problem data regarding the T-0 ground connector issue; and (4)

tabulating SSME problems newly opened, newly dispositioned, and newly closed as non-problems by month over the last 6 years.

In problem trending, PAC generated regular problem entry and disposition problem histories; issued monthly bubble trend charts with interpretations of data; and, in coordination with QD40 Reliability and QD20 Shuttle Assurance, continued to define and implement significant enhancements in problem trending. A standard format for problem trending was defined, briefed to the PAC engineers, and implemented through the new software report format. The PAC also participated in the NESC-sponsored Data Mining and Trend Analysis Conference at Glenn Research, representing the MSFC problem system in interpreting the MSFC PRACA data and interfacing with NESC and other NASA personnel regarding needed improvement in Constellation PRACA to more readily support these types of analysis.

In implementation and operation of the MSFC Corrective Action System (CAS), PAC received 20 potential CAS reports, screened 19 draft Recurrence Control Action Requests, elevated 5 to new Recurrence Control Action Requests (RCARs), coordinated 7 point of contact (POC) responses, and facilitated 5 Corrective Action Boards (CABs) resulting in closure of 5 RCARs. HEI also provided and discussed CAS metrics and open RCAR status reports at Marshall Management System (MMS) Implementation Team meetings, and issued monthly RCAR status and delinquent response reports. A review of the Corrective Action System processes and records during the QD internal audit resulted in no adverse findings.

4.2.3 ALERT Program

HEI's ALERT support included both regular and special activities as HEI coordinated MSFC ALERT processing and participated in the NASA and general Government-Industry Data Exchange Program (GIDEP) activities. HEI received and distributed 19 ALERT announcements for MSFC review and obtained 1,481 responses from MSFC project, contractor, and laboratory contacts. HEI also worked with the transformed MSFC organization to re-establish ALERT contacts and tie them in with their new departments/directorates. HEI ALERT support personnel 1) reviewed and approved 4 new MSFC ALERT database accounts via the TPS security; 2) generated monthly Open, Delinquent ALERT response tabulations and provided them to S&MA and/or Directorate single points-of-contact responsible for open ALERT reduction; (3) researched and provided a 1994 ALERT regarding PIC diodes in support of STS-114 ET/SRB Mate Review and further discussions at the Shuttle R&M Working Group; and (4) developed and provided revised ALERT processing metrics with the QD20 and QD40 S&MA organizations. As Chairman of the Industry Advisory Group (IAG) of GIDEP, HEI participated in monthly GIDEP Executive Committee teleconferences and circulated notes to the IAG membership, reviewed and updated the IAG membership nomination letter, answered questions from prospective candidates, assisted evaluation of 4 proposed GIDEP data system changes, and brainstormed future IAG officers with the formed IAG chairman.

4.3 Quality

Space Transportation

Space Shuttle Main Engine (SSME) Quality Engineering (QE) evaluated Program, Project and contractor engineering changes for quality impacts and participated in daily Program and Project meetings. QE also participated in an evaluation of Boeing/Rocketdyne's practice of making

modifications to hot fire certification requirements without documenting them on an Engineering Change Proposals; these changes are only visible to NASA as part of follow-on Verification Complete Reports. QE supported the Aft Nozzle Manifold Ablative Redesign Critical Design Review. SSME QE is in the process of conducting an evaluation of S&MA requirements flow-down from NSTS 07700 to the contractor's implementing Standard Operating Procedures. This evaluation is being conducted to verify adequate requirements coverage through the various levels of compliance documentation.

Solid Rocket Booster (SRB) QE continued to support the BSM graphite throat Factor of Safety (FOS) tiger team meetings. QE continued day-to-day activities which included support to weekly Booster Separation Motors (BSM) Integrated Process Team (IPT) meetings, BSM Plume Characterization Team, Return to Flight Action Review, and RTF Technical Interchange Meetings. QE prepared and presented technical issue briefings to S&MA upper management.

SRB QE provided support to the Automated Dynamic Acceptance Procedure Test Stand (ADAPTS). QE participated in the ADAPTS Activation Test Readiness Review.

SRB QE continued participation in the SRB ATK Booster Separation Motor (BSM) Alternate Source Team activities. This has included support of a Foreign Object Elimination Audit, which was performed at ATK.

SRB Pyrotechnics QE supported the Pyrotechnics S&MA in the review of the redesigned NASA Standard Initiator Pressure Cartridge Qualification Test Report. QE participated in the SRB Confined Detonating Fuse Initiator Lot ABM Phase III Review at Pacific Scientific, Chandler, AZ.

QE supported the Confined Detonating Fuse (CDF) Initiator Delta Qualification Test. This included the post functional burst pressure test conducted at MSFC. QE also participated in the inspection of CDF Manifolds at the Ordnance Storage Facility, KSC.

QE participated in detailed audit of Starfire Systems, manufacturer of the material resin for the repair of the Reinforced Carbon Carbon surfaces of the Orbiter.

External Tank (ET) QE continues to support the Excitation Power Box (EPB) activity. QE reviewed all the open Review Item Discrepancies (RIDs) for the board review. QE reviewed and approved drawings and test procedures for the EPB. QE participated in weekly Space Shuttle Program Quality panel meeting.

QE continued support to the External Tank Design Certification Review and reviewing and approving new and updated Hardware Certification Sheets and Certificate of Qualification sheets at Michoud assembly plant in Louisiana.

QE participated in an ET Bellows Heater System Requirements Review (Cork or No Cork on Heaters) to determine whether to proceed with Cork or No Cork for the heaters. It was determined that they would not use cork.

Reusable Solid Rocket Motor (RSRM) QE supported the critical design review (CDR) for the RSRM Intelligent Pressure Transducer (IPT). QE is updating all affected Certificate of Qualifications which will be submitted 45 days prior to the first flight of this change.

Software Quality Assurance (SQA)

Software Assurance (SA) completed the Intermediate Concepts of the Capability Maturity Model –Integrated (CMMI) Models training presented by the Carnegie Mellon Software Engineering Institute. This training will assist the SA group in obtaining a higher level of certification; currently the group is assessed as a Capability Maturity Model (CMM) Maturity Level 3 organization. SA has continued to witness formal verification and validation testing of the Material Science Research Rack flight software Operational Increment 3.0.1.1; this activity included submission of Software Change Requests to document the observed anomalies and necessary document updates. SA baselined version 1.3 of the Orbital Express (OE) Flight Software Code and reviewed the OE Optical Characterization Test Procedures with Boeing, NASA and the Project Office.

ISO/AS9100

QE has continued to play a key role in ensuring the maintenance of ISO 9001 and AS9100 at MSFC during this time period. Efforts have dealt with continuing implementation of ISO 9001 and AS9100, maintenance of documentation, and planning and support for the NQA registrar surveillance audit, including preparation of self-assessment checklists for the MSFC organizations, escorting during the audit, and follow-up and closure of corrective actions. QE provided general ISO and AS9100 support, including Marshall Quality Council (MQC) meeting preparation; reviews of both MSFC and NASA Agency documentation; and consulting support on internal audits and other aspects of ISO 9001 and AS9100 to various MSFC Organizations. QE began working on a new charter of the Marshall Management System (MMS) team as a committee under the Integrated Management System Board (IMSB).

Payloads

QE performed drawing reviews, procedure reviews, test readiness review, and procurement reviews, inspection requirements, shipping requirements, and supported team meetings for ECLSS, GBM, MSRR, Solar-B, and MSG. QE reviewed and provided comments for safety verification closures for ECLSS. QE provided quality expertise to Material Review Boards for ECLSS, MSRR, g-LIMIT, LOCAD and MSG. QE conducted a Quality Review of data submitted by the Naval Research Laboratory and Mullard Space Science Laboratories (MSSL) in support of a Test Readiness Review for Solar-B's Mechanism Driver Electronics. This TRR was conducted at MSSL located in Peaslake, England. QE reviewed and provided comments for safety verification closures for ECLSS. QE provided quality expertise to Material Review Boards for ECLSS.

Inspection and Test

QE, in support of QD10, participated in the Contingency Plan Development for the Autonomous Rendezvous Technology (DART) Project Office. This plan has visibility to NASA Headquarters due to the large number of personnel that must be notified in case of a mishap, including Headquarters' personnel.

Quality Assurance (QA) personnel provided hardware inspection, test surveillance and document review support to the following QD30 projects: Environmental Control and Life Support System (ECLSS), ECLSS's Oxygen Generation System (OGS) and Urine Processor Assembly (UPA), Microgravity Science Glovebox, Delta-L, Material Science Research Rack, and Solid Rocket Booster and External Tank return to flight testing activities. Receiving inspection was performed on hardware for multiple flight projects, assuring compliance to all requirements. QA personnel provided hardware inspection, test surveillance and document review support to the following QD10 projects: External Tank Return to Flight Testing of 3"x 5" panels and Intertank Flange Qualification Testing, 24" Solid Fueled Motor High Pressure Grain Test, and weld inspections on the new facility gaseous hydrogen piping at Test Stand 115.

4.4 Information Management (IM)

Information Management (IM) provided significant improvements in data search and trending methods this quarter. The Problem Reporting and Corrective Action (PRACA) application was revised to improve search and trending capabilities and to improve the user interface. IM developed a function allowing users to attach .pdf files to problem reports; completed the Historical Data report; completed the download to Excel functionality for two reports; completed functionality to download the Milestone Open Problem report to a Word document; and incorporated new requirements for the Open Problem List (OPL) report. IM also assisted QD20 in establishing a methodology for storing documents using the Center's Repository software such that privileges can be adequately controlled and effective search capability will be provided. IM also prepared numerous documents for scanning at the Repository and inclusion in the database.

Numerous applications were developed or modified this quarter. The Inventory of Hazardous Operations (IHOPs) application was modified to improve notification of required updates and to incorporate a change in the security structure. IM completed development of the Safety, Health and Environmental Corrective Action Item Tracking System (SHECAITS). The application was developed to assist the SHE team in tracking actions and produce reports about improvements as related to requirements. IM presented the application at a Marshall Operational Readiness Review (MORR) and subsequently met with developers of the Center's Corrective Action Item Tracking System (CAITS) to determine the modifications that would be necessary to use CAITS to meet SHECAITS requirements. IM provided a report to the Chief Information Officer's (CIO) representative outlining the requirements and associated cost. SHECAITS will be deployed upon the CIO's approval. IM provided a rewritten Customer Survey application; rewrote QD's Customer Feedback application; and created new graphs and reports from Customer Survey data. IM modified the program that updates personnel and organizations in the Supervisor Safety Web Page (SSWP) application. Due to the Center reorganization, 4 modules were modified to change the logic by which organizations are established, personnel are associated with those organizations, and organizations are related to each other. In addition, new fields were added that will be used by the Action Tracking Information System (ATIS) and by QD's integrated login application for assuring citizenship of those requesting access. SSWP was also modified to automatically check for citizenship and to improve the method by which privileges are granted. The SSWP Designee function was modified to improve Designee access methodology. IM completed a Construction module in the Safety, Health and Environmental Tracking (SHEtrak) application. The module provides for documentation of construction inspections, which are associated with multiple buildings. The module is in beta testing. IM

met with a representative of the MSFC EEE Parts organization to discuss the data interface with the As-Built Configuration Status System (ABCSS) and the Acute Launch Emergency Restraint Tip System (ALERTS). As a result, IM identified a method to provide needed data from ALERTS and detailed concerns regarding maintenance of the ABCSS application to the QD Information Technology Manager (ITM).

IM completed document reviews and data studies as well as performing market analyses and associated waivers in support of the ITM. The data studies also supported the QD CWC process by assuring the costs associated with QD assets. IM performed a yearly review of QD application users' accounts to assure conformance to security requirements. Email notifications were sent to users who had not accessed accounts within the required timeframe and many accounts were ended. In addition, the last date of IT Security training was updated for all users. Additionally, IM developers attended two training sessions.

4.5 Human Exploration and Development of Space (HEDS) Assurance

The independent assessment management information system database is being used as an information conduit with our NASA customer. The Independent Assessment analyst for each element updates the entries for his element as changes in issues, concerns, and status changes.

4.5.1 International Space Station (ISS) Independent Assurance

Activities for International Space Station Independent Assurance were very limited during this period; resources were focused on Shuttle RTF efforts

4.5.2 Space Shuttle Independent Assurance

The Independent Assessment of the Procurement Quality Control at Lockheed Martin (LM) Michoud (MH-4001) is complete. The formal out-briefing to the External Tank Project Manager was held on January 14, 2005. Several discussions have been held with LM Michoud Procurement Quality Assurance personnel to coordinate written assessment responses to the identified assessment Observations/Findings.

The Independent Assessment (MH-4007) of the Procurement Quality Control of the United Space Alliance's (USA) Solid Rocket Booster (SRB) is under way. In-briefings have been given to the SRB Project at Marshall Space Center (MSFC) and to USA SRB at Kennedy Space Center (KSC). The IA Team is continuing to gather and review the documentation for the SRM procurement contract requirements imposed on USA for the SRB contract as well as to develop rationale for selection of a small number of USA SRB prime suppliers for assessment of procurement requirements flow down. Once the suppliers have been selected, field observations of both USA SRB at KSC and the USA SRB prime suppliers will begin. The IA Team is in the process of generating checklist questions for these field observations.

The MSFC IA Team continues to support Assessment JKM-4004, "Return-to-Flight (RTF): Assessments of Products from SSP RTF Actions SSP-4 (Accepted Risk Hazards) & SSP-9 (Failure Mode & Effects Analyses/Critical Items Lists)." The products assessed have included a sampling of the Accepted Risk Hazard Reports and associated CILs for Launch and Landing, Integration, Orbiter, SRB and SSME. Presentations have been made by the Independent Assessment Team to NASA Headquarters Managers. These presentations have included interim

status and observations.

IA participated in the Propulsion Design Certification Review (PDCR) held in preparation of the return to flight mission currently scheduled for May 2005. The PDCR board was comprised of members from MSFC Engineering, Shuttle Project Offices, Independent Technical Authority, Astronaut corps and MSFC Center Management and was chaired by the Deputy Space Shuttle Program Manager for Propulsion. Each of the propulsion elements and Propulsion Systems Engineering and Integration groups presented the results of the redesigns and changes since the last flight and provided certification trails for meeting requirements. The PDCR was comprehensive; however, much open work remains and must be brought to a positive and successful conclusion prior to the STS-114 flight. The IA Team has no concerns beyond those expressed by the projects at the review.

IA participated in the Reusable Solid Rocket Motor (RSRM) Project Test Readiness Review (TRR) on January 20, 2005 in preparation of the firing of the Flight Verification Motor No. 1 (FVM-1). The stated purposes of the TRR were to delineate the test objectives and to ascertain the readiness of the Thiokol team to conduct the test. This firing will be used as a validation of the age certification, as this motor is very nearly the same age as the flight set planned for STS-114. The presentation included discussions of Problem Reports and Discrepancy Reports and the justification for testing in the stated condition. IA noted no concerns with the readiness of the RSRM Project to perform this test.

As a result of Foreign Object Debris (FOD) in the Space Shuttle Main Engine (SSME) pony foot area, activity has begun on a plan to assess the SSME FOD control program. A preliminary plan has been created; but, due to the extensive SSME return-to-flight (RTF) activity level, the assessment activities are being postponed.

IA Team participated in the External Tank (ET) Design Certification Review (DCR) II, Phase I review at the Michoud Assembly Facility (MAF) January 24 through February 2, 2005. The focus of the DCR II is primarily to provide certification of the thermal protection system (TPS) on the ET, including the TPS which was not redesigned / re-sprayed. The IAT evaluated the adequacy of the DCR II from the perspective of the review team make-up, the processes used for evaluation and RID documentation, and a sampling of the acceptability and completeness of the Hardware Certification Sheets and supporting data. The IAT concluded that the ET project failed to provide adequate certification rationale for all the Use-As-Is and Redesigned areas for TPS. This view was predominant across the review groups including the NASA Engineering and Safety Center (NESC) representatives. These findings were presented to the Safety & Mission Assurance (S&MA) Pre-board members in preparation for the Pre-board meeting.

In Preparation for the meeting of the ET DCR Board on March 8-9, 2005 at the Michoud Assembly Facility, the IAT submitted an Engineering Information Report which summarized the observations and recommendation through the Preboard meeting. Recommendations which included suggested wording for the board statement, the inclusion of risk assessments and the acceptability of the "Limitations" being proposed were briefed to the S&MA Preboard members. It was emphasized again in this briefing, that the magnitude of open work to be completed prior to return to flight presents added risk. The Preboard recognized that the traditional certification

approach for the use-as-is foam would not be possible. As such the Preboard, in conjunction with the ET Project, proposed a new "Verification Limitations Document" to be developed by the Project and approved by the Shuttle Program. This document would identify the limitations to the verification of the ET based on the "limitation" RIDs from this review, along with supporting rationale. According to the ET S&MA Lead, the Hazard Report will cover the limitations, and the Limitations Document will reference the Hazard Report. The Preboard also recommended that the "Non-constraint" RIDs be closed and tracked as "possible" actions by the ET Project, with the understanding that "actions" may never be done due to budget restrictions. A concern was expressed about this approach by one of the Board members, but no change was made. With no negative votes, all members of the DCR Board accepted all the Preboard recommendations and concurred with the DCR completion statement. The IAT had recommended to the Board's S&MA representative, that the DCR Board statement be revised to include conducting a risk assessment. This was discussed but the Board did not include this in the completion statement.

Due to the inability of the ET Design Certification Review (DCR) to certify the "already sprayed" thermal protection system (TPS) foam (i.e., use-as-is), the DCR Board agreed that Level II and Level III "Verification Limitations Documents" should be developed, identifying the limitations to the verification/certification process. These limitations are based on numerous RIDs written during the review which cited issues related to the processes used for certification. The use of this approach, i.e., the limitations documents, was acknowledged as acceptable by Level II representatives at the DCR Board. These documents are currently being worked in parallel, although the normal procedure is for the requirements to flow down to the Projects from the Program. Both documents have been provided for preliminary review in preparation for submittal to the Program for approval. The IAT has reviewed and provided comments to both the Level II and III documents.

During the trimming operation of the External Tank Intertank closeout foam, a delamination was observed. Upon review of the video recorded during the manual closeout spray, it was detected that the operator sprayed over rising foam which is known to contribute to the presence of delaminations. This event was not detected either at the time of application by the helper nor during initial review of the video. This condition was written up by Quality and will become a Materials Review Board item for disposition. Since this same process has been used for all the redesigned closeouts, this event may become a suspect condition for ET 120 and 121 hardware and require a disposition of the suspect condition.

MSFC IAT Members on the IAT performing the Ground Support Equipment (GSE) that interface with Space Shuttle Program (SSP) Flight Elements, JKM-3011, assessment participated in the "Separations Tiger Team Review Meeting", at KSC, February 1-2. The manager of the SSP Systems Engineering and Integration Office served as the primary moderator for the meeting. A number of issues/concerns identified by the IA Team (during the assessment phase) were addressed, and data/plans for problem resolution were also discussed. Static and dynamic testing operations were reviewed at length, and applicable data, plans, tests, and test results were reviewed by meeting participants. Upon completion of the review, the results were presented to the Deputy Shuttle Program Manager, and the decision was made to not perform a Flight Readiness Firing (FRF) prior to RTF. The tiger team recommended a number of changes which will help to alleviate the concerns of signal drop-out across critical interfaces. While the IAT

agrees that what the tiger team recommends is beneficial and might be adequate for flight rationale for STS-114, there are lingering concerns that there may not be an adequate push by the SSP program to fully understand the problem well enough to truly certify this part of the system. The IA Team did not feel that the program actions developed an adequate understanding of the root cause for the signal dropouts. As a result, they developed a dissenting opinion which they then presented to the SSP S&MA Directors, to the OSMA Director, and to SSP Program Management. As a result of their activity, there is expected to be more study of this interface, but there is no constraint to the launch of STS-114.

IA participated in a Technical Interchange Meeting (TIM) at Pratt-Whitney, West Palm Beach on March 15-16, 2005 on the history, problem investigation and future plans concerning the knife edge seal cracking on SSME High Pressure Oxygen Turbo Pumps (HPOTP). The knife edge seals of concern are integral components of the HPOTP. During the scheduled maintenance and overhaul of HPOTP units 8014R2, 8019R1, 8122, and 8023R2 cracks and/or missing material were found in the inner two tooth seal (F/N 72). On units 8016R4, 8023R2, and 8024 cracks were found on the four tooth seals (F/N 11). The KE seal fleet leader histogram shows that this cracking is a fairly recent occurrence on low run time units. This TIM was an update on the failure investigation and a summary of the work thus far to try to determine the root cause of the cracking. Pratt-Whitney, Rocketdyne and the NASA SSME personnel are using all their technical resources and expertise to try to understand the cracking problem and determine the best and safest approach to Shuttle RTF. The most likely cause of the cracking is acoustical flutter but the root cause of the cracking phenomena is not understood. The SSME Project is proceeding toward RTF with a 2 start Deviation Approval Request (DAR). The 2 starts would be one successful green run hot firing at SSC plus one flight. This is the most cautious approach to continue flying the Shuttle without understanding or correcting the crack problem. In addition to this option, the investigation will continue toward understanding the root cause of the seal cracking and implement corrective action to prevent it. If this is successful, there would be justification to fly the pumps more than once without disassembly. The other option discussed was a redesign / certification of the seals to make them more robust and immune to cracking. This option will be presented to management to discuss technical merit, cost and schedule. There are no IA concerns beyond those already being addressed by the SSME Project.

4.6 Project Assurance

Constellation Systems Risk SE&I Integrated Discipline Team Support

HEI Project Assurance Engineering (PAE) supported QD10 by completing and delivering a series of incremental drafts of the Constellation Systems Risk Management Plan (CSRMP) to the Systems Engineering and Integration Integrated Discipline Team (SEI IDT) Configuration Management (CM) Group. The drafts were placed into the collaborative review environment established in Windchill. PAE developed a CS IRP Change Package Presentation for the CSRMP Change Request (CR) and presented to the CSIRP. PAE then prepared the Constellation Systems Integration Board (CSIB) CR presentation for the CSRMP.

PAE worked on a spreadsheet of 'controversial' issues for the CSRMP. A plan was approved by the CSIB to work these issues through the Constellation Systems Risk Working Group (RWG). These issues are typified by things that the various Constellation Systems stakeholders needed to buy into or issues where a process was yet to be devised. The issues come from a rapid

succession of reviews of the CSRMP which yielded almost 600 comments, the disposition of which were all coordinated by HEI PAE. Most were editorial, many were accepted and 97 were rejected and sent to the RWG for consensus resolution. Those issues were gleaned from the respective reviews (different formats), and collated into a single worksheet (single format). Priorities have been assigned to the issues and they have been sorted accordingly.

PAE supported development of a presentation for the first Constellation System Risk Management Working Group (CSRMWG) teleconference. PAE is compiling current risk lists from the Constellation System Systems Engineering Integration teams in preparation for the CSRMWG. Currently this data is being entered into an Excel spreadsheet. PAE has initiated work to make this spreadsheet more compatible with the Active Risk Management (ARM) tool.

PAE initiated and is continuing the effort to draft a charter for the CSRMWG. Requests were issued for charters from similar groups to use as boilerplate for the CSRMWG. PAE prepared minutes were prepared for the CSRMWG telecons and attended Systems Engineering and Integration (SE&I) Integrated Discipline Team (IDT) meetings and the overall Constellation Systems IDT telecons.

Constellation Systems S&MA Integrated Discipline Team Support

PAE drafted and provided change package engineers (CPE) for the Constellation S&MA Plan and the Constellation Quality Assurance Requirements document. The draft plans were sent out for review, comments were received, reviewed and dispositioned. Reviewers included the NASA Headquarters Constellation Office, NASA Headquarters Exploration Systems Mission Directorate (ESMD), and NASA Centers points of contact. The documents were subsequently presented to the Constellation Systems Integration Board (CSIB) for approval. Both documents were approved and are baselined and then released for further review. PAE subsequently updated the Constellation S&MA Plan to reflect data related to the Columbia Accident Investigation Board report. The updated Plan was uploaded to the Windchill database for team review and comment. PAE is populating the Constellation System Engineering Management Plan (SEMP) with required S&MA sections. PAE also participated in review of the Constellation S&MA documents for the Propulsion & Fluids IDT.

Propulsion Development Projects Support

PAE participated significantly in assurance activities for propulsion development projects including participating in the Test Readiness Reviews (TRR) and the resolution of non-conformances observed during pre-acceptance and acceptance testing of the Aerojet Reaction Control Engine (RCE). PAE continues to support the ongoing acceptance test series by participating in test data reviews, reviewing the build paper, and verifying that any/all anomalies and non-conformances have been properly processed and closed out.

PAE represented S&MA at the Integrated Powerhead Development (IPD) Test Readiness Review (TRR) in January. A total of 237 hazards were identified with none being categorized as single point failures capable of resulting in category 1 or 2 events. PAE continues to participate in the ongoing mitigation process.

After completing a review of the AFRL (Air Force Research LAB) Incident Response Plan, PAE assisted in formulating a proposal to the STPPO Executive Management Team at NASA Headquarters regarding exceptions to incident reporting requirements contained in both the AFRL plan and NPR 8621.1. The proposal resulted in an agreement under which the exceptions would be applicable for test article (hardware) only failures. The intent was to reach an agreement under which the facility portion within cell 3 of stand E1 would be treated as part of the test article.

Shuttle Propulsion Elements Support

PAE provided significant support in assurance activities of Shuttle propulsion elements including MRB support on RSRM Pressure Sensitive Adhesive (PSA) shelf life issues and reviewing ECPs and change requests (CR) related to the SRBE (Solid Rocket Booster Element) program. Documents were reviewed for impacts to the FMEA/CIL, System Safety Hazard Reports, hardware certification requirements and Certificates of Qualification (COQ). Additional PAE efforts have focused on the review and consolidation of change requests from the MSFC elements and review of Integrated Hazard Reports for S&MA Integration. PAE has worked with the customer to develop a format for tracking review comments for the Integration Team. PAE also populated the RID database for JSC in preparation for the Integrated Safety Engineering Review Panel.

4.7 Risk Management and Risk Assessment

4.7.1 Risk Management

During 2nd Quarter of Fiscal Year 2005 Continuous Risk Management (CRM) continued to support the Exploration Systems Mission Directorate (ESMD) (QD10) by defining roles and responsibilities for the ESMD Active Risk Manager (ARM) users. A final agreement was reached with the establishment of five distinct roles for ARM users. CRM personnel also provided additional comments and had graphics produced for the ESMD Risk Management Plan as well as incorporating process updates into the plan. CRM reviewed comments on ESMD's Risk Management Policy document during this period and developed a risk requirements tracking process to zero in on CRM requirements for the tiered levels of ESMD program/project management. This process will aid in the development of risk management documents for incorporating throughout ESMD. CRM provided comments and feedback to the beta version of the ESMD Risk Management Handbook. The comments will be consolidated, reviewed, and implemented in the next revision of the ESMD RM Handbook. Additional CRM support was provided by: participating in the ESMD Office of Program Risk Assessment (ORPA) establishment of the ESMD enterprise risk management process, performing an analysis on Orbital Space Plane (OSP) risk statements to help identify good risk statements versus bad risk statements, reviewing and commenting on the ESMD risk escalation process developed for implementation into the ESMD risk management plan and assisting QD10/NASA personnel in the development and presentation of an overview of the Office of Safety & Mission Assurance Requirements Tracking (SMART) database to S&MA's Director. The SMART database will assist S&MA personnel in developing requirements driven documents. Lesson plan development and training for this effort are to be discussed in the near future.

Risk Management's (RM) support to QD20 continued through its participation in the Space Shuttle Program's (SSP) bi-weekly Risk Management Working Group meeting in order to define

risk review board processes, review and comment on the new SSP risk summary card and review SSP Hazard Analysis report interfaces with the Shuttle Integrated Risk Management Application (SIRMA). The new version of the SSP risk management data base SIRMA is currently under beta testing prior to release of which MSFC's SSP risk management group is a part. RM is currently conducting a final review and comment on the new SSP risk summary card for submittal to the SSP Risk Management Office at JSC. RM personnel also submitted for SSP Risk Management's approval a presentation outlining the benefits of MSFC CRM certified instructors to implement a training process to support SSP Risk Management and SIRMA training at MSFC.

CRM support to QD40 was provided through its Continuous Risk Management Assessment process and documentation, Active Risk Management (ARM) Training, CRM course revisions to incorporate new NASA CRM requirements and reviewing the Shuttle Integrated Risk Management Application (SIRMA) training requirements to support Shuttle related programs/projects located at MSFC.

CRM successfully conducted a Continuous Risk Management, half-day course this quarter to fulfill a MSFC 2005 Program Planning & Control Course Requirement. This course provides an overview to program/project managers (i.e. ICE ARM, Discovery Program) and other interested employees as to how CRM can be implemented/maintained in their programs. The next iteration of this course will include Probabilistic Risk Assessment (PRA), Earned Value Management (EVM) and Failure Modes & Effects Analysis (FMEA).

CRM personnel participated in the QD40 Independent Assessment Monthly Status Review. Key metrics of CRM activity were identified to include the instruction of two hundred and three students in CRM theory and application from CY 2004.

CRM personnel are currently reviewing documents and text on the CRM web site for accuracy and correctness on web links along with compiling information on the ARM to develop a promotional overview for the CRM web site.

CRM personnel met with QD40 CRM Leads to develop a presentation that outlines the current capabilities, roles and responsibilities that HEI performs in supporting QD40 and the CRM process. This presentation was given to the S&MA Executive Management Team to help in the development of future resource and budget requirements for the S&MA office and Independent Assessment.

CRM personnel are currently reviewing all risk related requirements this quarter in an effort to revise/develop more concise risk management plans for all MSFC programs/projects. The test site of the Safety & Mission Assurance Requirements Tracking (SMART) database is being used in this effort. The review has yielded one hundred and fourteen requirements dispersed in a myriad of NASA documents. The goal of this exercise is to use these requirements to develop a risk management skeleton for constructing risk management policy and program plans.

CRM attended the Work Breakdown Structure course which is designed to provide an overview on establishing a task based structure that is linked to the program's organizational structural.

Linking risks to a program's WBS will aid the program manager in identifying technical risks to a specific task that has been funded and will help narrow the cost estimate of the risk impact. Implementing WBS concepts into CRM training will help in identifying additional risks and risk mitigation processes.

CRM co-presented with QD10/NASA an overview on the NASA HQ Safety & Mission Assurance Requirements Tracking System (SMARTS) to the S&MA Executive Management Team. The SMARTS application aids in the identification of S&MA requirements and how they will be incorporated into MSFC Program/Project documentation. The goal of this presentation is to identify an MSFC Project that could benefit from this process and conduct the necessary training on using the SMART application.

The CRM Team conducted a Two-Day Systems Engineering CRM Course with a workshop. This course was presented to the MSFC Systems Engineer Group as part of their NASA training. The course implemented newly revised training material from the Continuous Risk Management Corp. and the CRM team. Also added to the course curriculum were an overview of Earned Value Management and an in-depth overview the Probabilistic Risk Assessment process.

Risk Management Corp. (RMC) (NASA HQ) performed a certification review of the MSFC CRM Team this quarter (NASA and HEI). All the instructors, instructional processes and training material was examined and reviewed by RMC. The RMC evaluators were impressed with the flow of the instruction as well as the presentation skills of the CRM Team. However, based on the recommendations of the Risk Management Corp. CRM evaluation team reviewed and revised the two-day risk management course to include updated training material, slide animation, workshop material and handouts.

4.7.2 Space Shuttle Probabilistic Risk Analysis

During 2nd Quarter of Fiscal Year 2005 Shuttle Probabilistic Risk Assessment (SPRA) was tasked to support the Space Shuttle Program (SSP) by making changes to the SRB's phenomenological and functional final reports. The SRB PRA phenomenological final report has been resubmitted to the MSFC Project Office and USA Engineering for review. Tables have also been created for the Appendix of the SRB functional final report and submitted to JSC. Fault tree extractions from SAPHIRE have been completed in order for them to be added to the Appendix of the SRB PRA Systems Notebook. A review and editing of the SRB System Notebook to fit the new outline is currently in progress.

SPRA wrote the SSME portion of the phenomenological data analysis report and submitted it to JSC for integration this period. SPRA also reviewed and commented on the integrated draft of the SPRA model integration, functional data analysis and phenomenological data analysis reports, worked with JSC's PRA model integration lead on reviewing the propulsion elements and integration hazard reports, and cross referenced them to existing SPRA models. Additionally SPRA worked with the model integration lead on resolving SAPHIRE model integration issues.

SPRA attended the Shuttle PRA (SPRA) TIM this quarter with the SPRA Independent Peer Reviewers (IPR) in order to discuss the SPRA Iteration 2 models and results. SPRA helped answer questions regarding SSME, RSRM and ET PRA modeling updates since the last IPR

TIM. SPRA also discussed improvements to the documents with JSC's SPRA teams, and ideas for sensitivity analyses that can be accomplished promptly. The sensitivity analyses will be the first step in an attempt to address modeling uncertainty in the current SPRA.

SPRA tasks on the RSRM this quarter consisted of working with ATK-Thiokol on updating the draft RSRM PRA system notebook. The draft report has been forwarded to MSFC SMA and RSRM project office for review. Additional SPRA support to the RSRM element was the documentation of the Expert Elicitation process, submitting it for review and having it approved by the SPRA reviewers for inclusion into the Functional Data Analysis Book; PRA Iteration 2. SPRA has since provided a review and edit of the Functional Data Analysis Book and the Phenomenological Data Analysis Book for the Iteration 2 PRA. Comments have been incorporated into both documents by their respective book captains and the final versions delivered for consideration in preparation for the Independent Peer Review Panel meeting.

SPRA participated in the weekly telecon meetings conducted at NASA JSC, on the Space Shuttle PRA; to provide comments on the External Tank (ET) including seal leak analysis as well as providing revisions to drafts on the ET input for Sections of the Phenomenological Data Report. SPRA reviewed, edited, and rewrote the ET Section of the Phenomenological Data Report incorporating comments from SPRA analyst. This document was distributed for final internal edits, received internal concurrence from the HEI SPRA analyst and delivered to its book captain for final tech editing. SPRA participated in the Space Shuttle PRA Meeting at NASA JSC with the Independent Peer Review Committee concerning the Phenomenological Data Report and revisited the basis for the ET Leak Frequency analysis based on the use of FRAS. SPRA completed its support of revisiting the development of priors and likelihood functions for ET functional components as part of Iteration 3 efforts. ET PRA reviewed the latest version of the External Tank (ET) Phenomenological Report sent to NASA JSC by HEI and provided comments on the Main Body document and Appendices document. SPRA also reviewed/revised and delivered a final draft of the ET System Notebook. SPRA has submitted its latest revision and updates to JSC on the Internal Task Agreement (ITA) proposal. The proposal is for MSFC S&MA and HEI to provide primary support for the Space Shuttle Probabilistic Risk Assessment (SPRA) for the remainder of Shuttle PRA Iteration 2 and all subsequent shuttle PRA iterations. Iteration 2 PRA was completed this quarter with Iteration 3 efforts to begin shortly. If approved HEI will be the primary PRA analyst for all shuttle propulsion elements. SPRA has completed its debugging efforts of the Itemsoft QRAS (beta) software and has recently submitted a MSFC SMA-HEI QRAS RTOP proposal. Training for SPRA consisted of attending the RAMS conference in Alexandria, VA.

4.7.3 Shuttle Reliability Prediction and Risk Analysis

During 2nd Quarter of Fiscal Year 2005 Shuttle Reliability, Prediction & Risk Analysis (RA) continued to provide support through involvement of this quarter's technical review of the Heat Shield Retainer Issue with SSME/ Boeing- Rocketdyne. The briefing of the issue was approved with minor changes and allowed to proceed to the Chief Engineer for closure.

RA continues with it dedicated support in updating the SSME ultrasonic fastener stretch measurement equipment. This equipment is being revised by relating Erdman counts to load and then relating load to delta time. RA was asked to analyze the data for this testing. The main

testing is being performed at Canoga Park and MSFC is performing a portion of the testing in order to evaluate differences in location and to assure the accuracy of the readings at Canoga Park. RA was asked this period to participate in a sub-team in order to set up the transducer reseal experiment that determines variability in transducer reseals for ultrasonic pulse readings. RA contributed to the overall design of the experiment (DOE) as suggestions and changes were made to the original DOE. RA prepared the test data recording sheets for use in the experiment and analyzed the results. A presentation of these preliminary results were prepared and presented the week of 2/28/05. After additional and refinement analyses of this experiment were performed RA determined that the experimental setup was not optimal for analysis. Most of the results of interest were however derivable. Preliminary analysis indicated that different transducers of the same type have different biases; different operators could have different, though seemingly small, biases; readings on different days may have a significant but small effect; stretching a bolt as a result of testing may not cause a repeatable effect; and repeated transducer re-seating appears to be independent and random, that is, one reseating does not affect results from the following reseating. The results of this analysis have since been presented to the Erdman team by RA. Additional and refinement analyses continue to be worked. RA participated in the transducer reseating experiment and has provided recommendations for verification testing and the beginning part 2. RA is currently analyzing the Engine 0527 data.

RA characterized two techniques of nondestructive evaluation (NDE) flaw detection for probability of detection (POD) on the SSME's MPS downstream flow liner this period. RA performed a preliminary analysis on incomplete data from a test using flaws manufactured in panels using an electrical discharge cutting technique. Initial results include surprisingly high sensitivity of the techniques used but low effect of operator(s) on detection probability. RA traveled to KSC to witness the measurement process, meet the engineers and operators, and discuss and design test matrices in order to characterize two nondestructive evaluation (NDE) methods. RA performed a preliminary analysis on real cracks in panels simulating slots in flow liners. This initial analysis suggests that major influences on probability of detection naturally included the length and/ or depth of the flaw. The position of the flaw in the slot, which is shaped like a rectangle with semicircular ends, also appears to be key, with flaws in the far ends being the most difficult to locate. There was also a significant influence due to the operating technician. This last finding is different than what was preliminarily concluded from POD data on machine-cut slots rather than cracks. Some of the findings may not agree with current understanding about the measurement process; a meeting with the team to discuss the analysis has been planned.

Predictions Analysis (PA) recently submitted a progress report this quarter on the RSRM's O-ring resiliency testing. Predictions Analysis made recommendations to improve repeatability of tests and attended meetings with MSFC engineers and Thiokol personnel to discuss details of a free response tester used in the past for O-ring testing. A review of three test plans was conducted on the RSRM nozzle tests, along with making several comments on each test at regularly scheduled table top conferences. An evaluation was also performed on data gathered from O-ring tests so as to improve testing repeatability.

Predictions Analysis analyzed 31 Booster Separation Motors (BSM), using capacitance data and minimum bond lines as measured by Southern Research Institute. By using 21 randomly selected

motors it was determined that an equation can be used to predict future bond lines with only a capacitance reading. Limits for this error were derived for the equation and the results were tested by predicting the bond line thickness for the remaining 10 motors of the 31 samples. The predictions were within the error limits of 26 % at a confidence level of 99%. This analysis was independent of the one conducted by USA personnel who are also members assigned to the BSM tiger team. However the results were very similar and served to prove the results of both. Predictions Analysis is currently conducting an error propagation study of the Factor of Safety (FOS) calculations of the BSM work. Predictions Analysis also reviewed graphite material properties which are inputs into the FOS determination for the SRB's BSMs; a search continues for the tolerance on these quantities. Predictions Analysis has also reviewed the thermocouple measurement data from the SRB's BSM test firing by Thiokol engineers and began its error analysis of those measurements and analysis that depend on those results. As a result of these efforts Predictions Analysis has written a technical paper regarding the recent work on this BSM project. This technical paper will be co-authored by other MSFC engineers and statisticians and is due for release in April.

RA reviewed the Flex Boot test plan for the RSRM Nozzle Project. The intent of this test is to replace the boot containing asbestos. The plan is to test 3 or 4 possible replacements using the current boot as a reference. Prior test reports have shown that hardly any tolerances on results with boot torque have been a major deciding factor. It was pointed out that much of the torque data in the equations contained errors that could obscure results. An error analysis or flex bearing torque could be used to detect differences if its short term stability (affected mainly by temperature) is satisfactory. ATK-Thiokol is to respond with data to substantiate this fact.

Predictions Analysis performed BSM error analyses on temperatures from two test firings. An open question was discovered on converting thermocouple voltages and reference junction temperatures to 0° C. It was determined that the highest temperature average +/- 375° F to be the appropriate error limits. Graphite property tolerances (elastic modulus, coefficient of thermal expansion, ultimate tensile strength, etc) were developed for use in the Finite Element Analysis by USA in order to provide an experimentally based Factor of Safety (FOS) with tolerances. Additional material data properties (i.e. tensile strength, coefficient of thermal expansion, elastic modulus, etc) used in calculating the FOS were also gathered on bond-line adhesive, aluminum and other inputs (temperatures, pressures and geometries-locations where stresses, forces, and displacements occur). The FOS relates to the release of debris from these BSMs. Since the various material properties and other inputs have tolerances the FOS will also have a tolerance. This fact and the development of FOS tolerances is an on going topic of considerable discussion within the BSM project tiger team.

RA reviewed ATK-Thiokol's presentation on expected RSRM debris, ice and rust/scale, at liftoff. The preliminary results used ice densities that were considerably different from that of handbook values. The value quoted was 46lbm/cft for ice and 489lbm/cft for rust/scale. After some research RA determined that the ET contractor (Lockheed Martin) measured the density of ice from the LO2 feed line bellows to be 46lbm/cft +9lbm/cft, -18lbm/cft. From the ET acreage the density was 56lbm/cft. The density of rust/scale data is still being sought at this time.

RA reviewed and revised for accuracy previous comparison analyses on BX-250 vs. BX-265 Automatic and Manual Thermal Protection System (TPS) foam spray data, BX-265 Manual spray new vs. old tin catalyst foam formulation data and BX-250 vs. BX-265 densities from tank dissections. Presentations of this information have been placed on the ET RTF website. RA also supported the ET RTF Statistical Support Team by characterizing a new tin lot due to a catalyst in BX-265 urethane spray foam being updated by the manufacturer. RA was tasked with characterizing the foam containing the new component and finding whether was significantly different from the old formulation. The data was collated, preliminarily examined for completeness, and the bond tension property analyzed and characterized. The results from this analysis indicated that by comparing Bond Tension (BT) between new and old formulations of BX-265 spray foam contained slightly different tin catalysts. Given the data, RA found no difference between the new and old formulas in this property. RA also characterized the family of raw material foam lots. The amount of cohesive failure at the knit-line during the test, differences between panels, that is, spray-to-spray differences, and differences within panels were also found to be significant. There was also probably an effect caused by the temperature at which the foam was sprayed; the lowest permissible spray temperature gave the lowest BT result.

RA worked with Lockheed-Martin personnel to craft language for the CIL document. The new section takes credit for positive steps taken by Lockheed in using data-based methods to show that new foam spray processes are likely controlled, predictable and repeatable. This is a necessary step in proving that acceptance criteria for these processes and products are truly being met. RA had earlier analyzed TPS foam densities generated from dissection and QC tests on flight hardware. The characterization of this as-built density data was used to create bounds to determine likely masses of foam debris in a foam loss event. This included studies of automatic spray, manual spray and pour foams. RA wrote and submitted a report on the results of the analysis, including information on process control assessments. The report was critiqued by several statisticians, edited according to their input, and submitted to the Lockheed Martin ET team to be reviewed and eventually placed into the permanent RTF record.

RA supported ET's RTF Design Critical Review (DCR) II by reviewing test reports under report 809-9435, TPS Defect Characterization Testing. This report included much of the basis for the divot/ no divot curve underpinning assumptions of risk and safety given a distribution of void sizes created during TPS foam spray production. RA brought forth for discussion the merits of an advanced divot prediction model aimed at describing foam divoting behavior given a number of inputs. The model will be further amended due to RA comments. Two Candidate Review Item Discrepancy (RID) reports were written during the DCR; one involved insufficient analysis of data leading to conclusions stated in the report and another noted that test conclusions assume predictable production processes, but little evidence supports this, particularly in the form of statistical process control (SPC) and process capability analysis. RA also co-authored two Review Item Discrepancy (RID) items regarding; characterization and accuracy of the Plug Pull test for characterization of strength of sprayed foam insulation and characterized a propensity for foam to delaminate (even though sprayed within acceptable processing parameters) which included the affects foam has on flight hardware. RA worked with Lockheed Martin analysts to work out satisfactory answers to these submitted RIDs and provided recommendations for corrective action.

RA continued constructing test matrices focused on achieving the aims of the Nondestructive Evaluation (NDE) Probability of Detection (POD) team. Micro-focus X-Ray sample design and test matrices for a Gauge Repeatability and Reproducibility (GRR)/ POD study and examination of off-nominal alignment of the X-Ray head appear to be ready for production and performance. Backscatter (BSX) and TeraHerz (THz) test matrices for probability of detection (POD)/ gauge repeatability and reproducibility (GRR) and gauging measurement sensitivity to off-optimal instrument tilt, off-optimal standoff, environmental factors, gap between foam and substrate and BSX power settings were submitted. Another revision that takes into account comments by team members was delivered to the NDE POD team.

4.7.4 Advance Projects Risk Assessment

During the 2nd Quarter of Fiscal Year 2005, RA continued its support to Advance Projects (QD10) by authoring a revised draft of the Constellation Systems Reliability, Maintainability, and Supportability (RMS) Requirements Document to summarize all RMS and Probabilistic Risk Assessment (PRA) requirements for Constellation program/projects. RA dispositioned all comments made to the document in preparation for the Constellation RMS Requirements Document Team to present the major dispositions to the IDT board for approval. Additional updates to the document's requirements have also been completed due to higher level documents moving from draft to base-lined versions.

RA began working on and making refinements to the Constellation System's Probabilistic Risk Assessment (PRA) Methodology Document for the Constellation System's Integrated Development Teams (IDT). RA was asked to lead the development of the document, and has also started putting together an agency-wide team to contribute to the development of this document. RA has completed its updates to the document per the NASA-wide S&MA review, and submitted it to the IDT for their review.

RA took advantage of available training this quarter by attending the RAMS 2005 in Alexandria, VA. Included in the symposium were 18 introductory and intermediate tutorial sessions, 24 paper sessions with over 100 papers, and three panel sessions totaling over 80 presentation hours. The tutorials all qualified for Continuing Education Unit (CEU) credit. RA also attended a four hour presentation on the Columbia Accident Investigation. In addition, RA took the American Society of Quality Certified Reliability Engineer Exam and received official certification in the discipline of reliability.

5.0 COST REDUCTION ITEMS

Our continuing cross-utilization of employees, continuous analysis of work in progress to assure that application of resources meets the needs of the task, and the judicious acquisition and distribution of tools to enhance the efficiency of all team members allow us to minimize cost to the customer.